RAP® Energy solutions for a changing world

Trends and Innovations in the Power Sector

New Hampshire

Office of Consumer Advocate Advisory Board

Presented by David Littell
RAP Principal

October 24, 2016

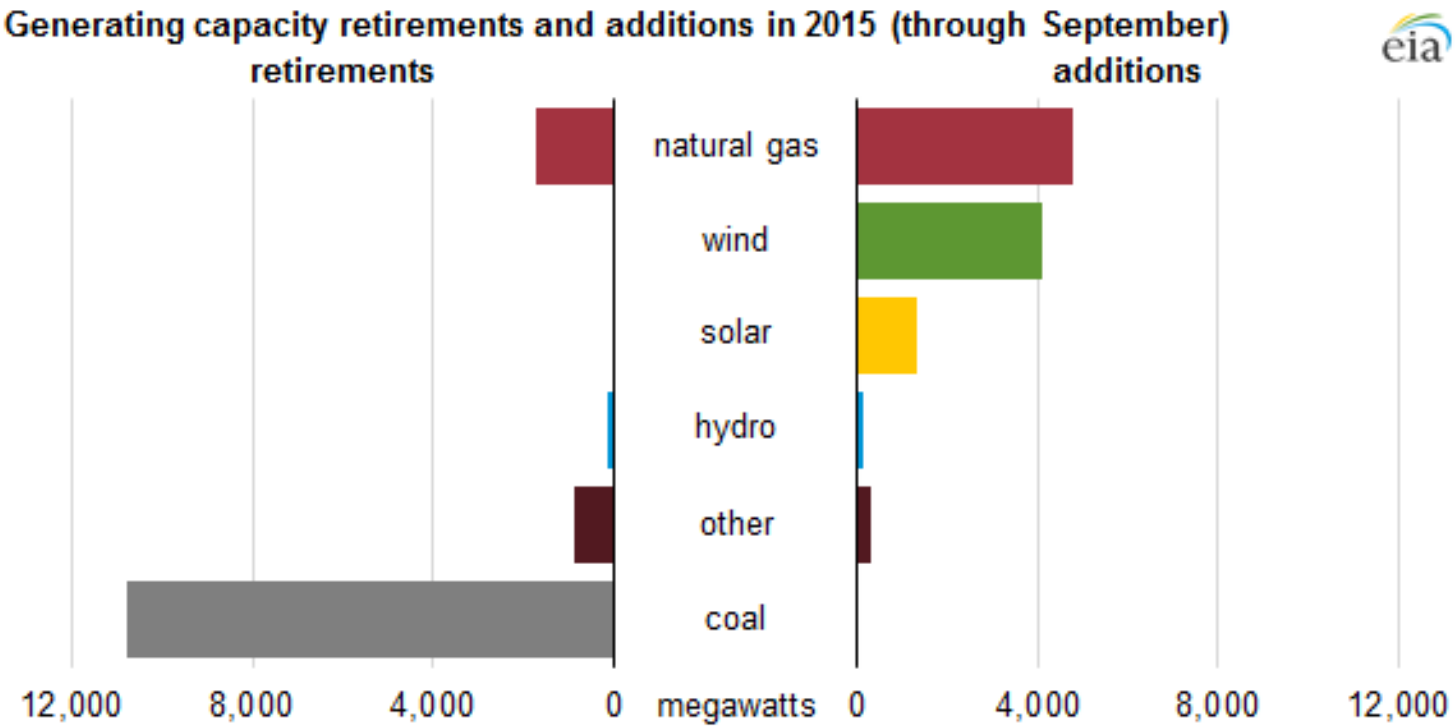
RAP

- The Regulatory Assistance Project (RAP) is a non-profit organization providing technical assistance and advice to government officials on energy and environmental issues. RAP staff have extensive utility regulatory experience. RAP technical assistance to states is supported by US DOE, US EPA and foundations.
  - David Littell is a principal in RAP's US Program. Former Maine PUC Commissioner and Maine Environmental Commissioner for 11 years and former private regulatory attorney for 11 years.

Overview

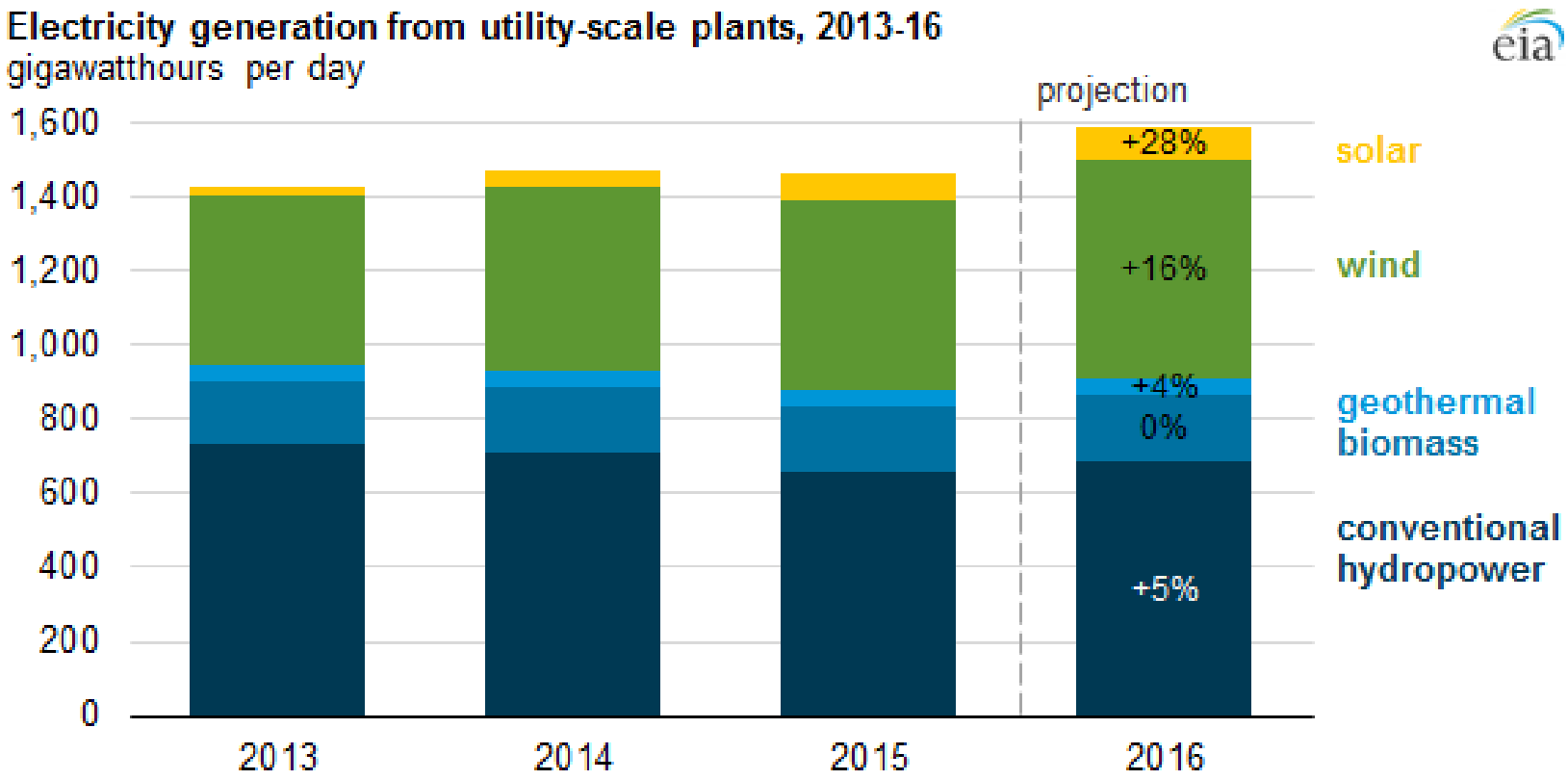
- Power Sector Transformation Trends to Date
- Advanced Energy Technologies
- Energy Production and Pollution Linkage
- Smart Rate Design
- Replicating Competition >> Encouraging Competition?

Generation Retirements and New Builds in 2015 Exhibit Growth in Gas, Wind, and Solar



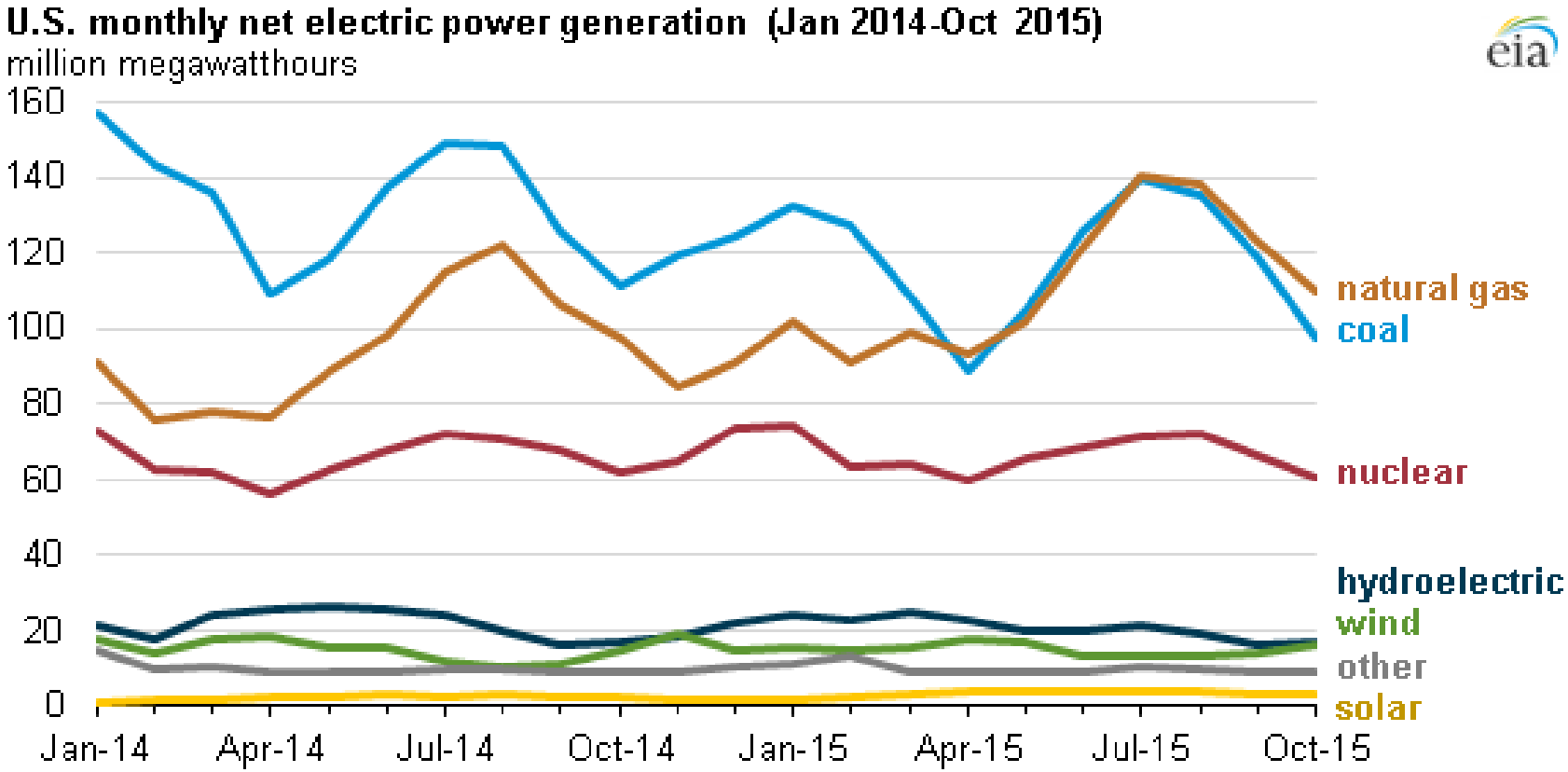
Source: U.S. Energy Information Administration, Form EIA-860, Form 860M

EIA Projects 9% Renewables Growth in 2016



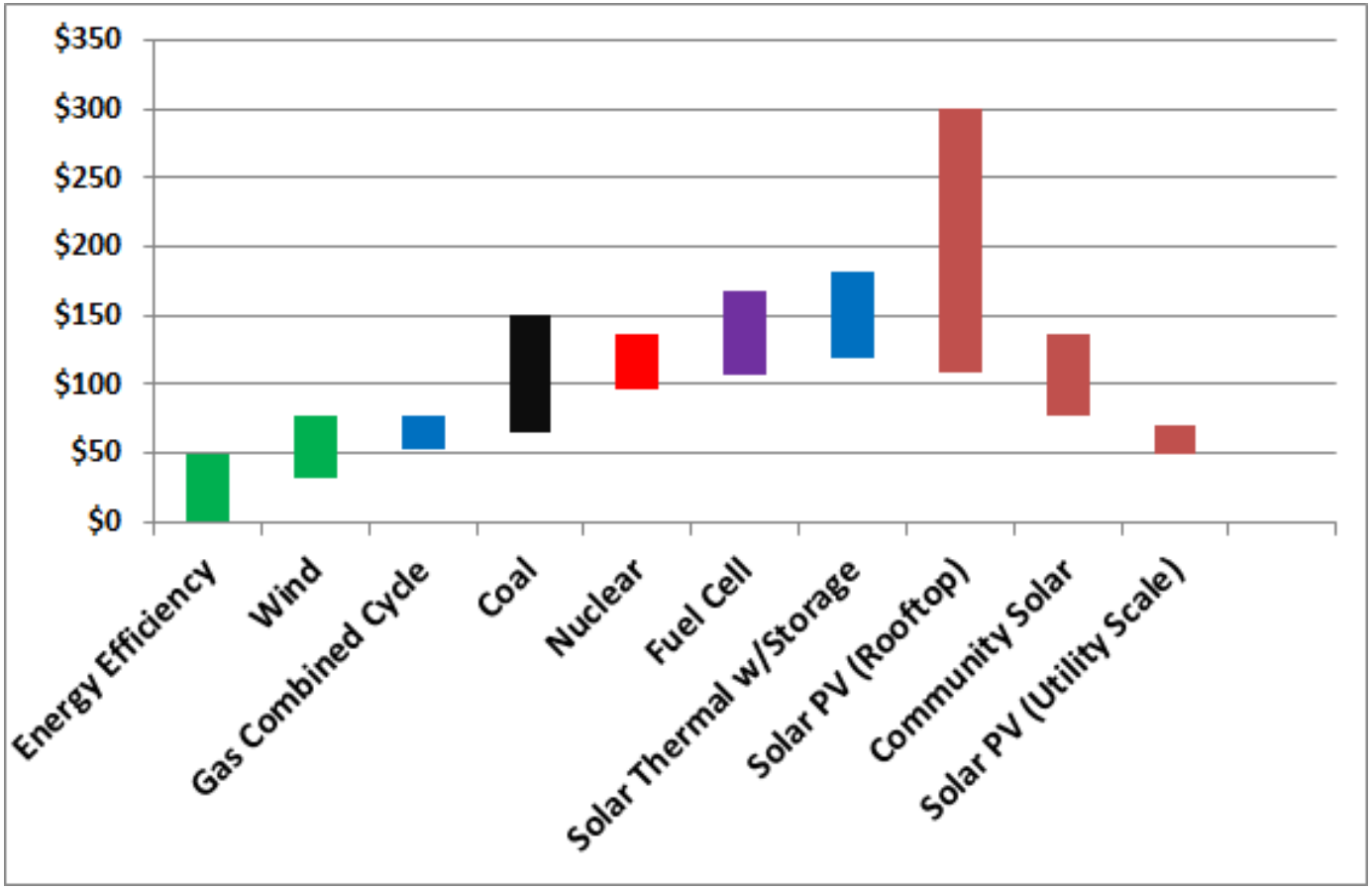
Source: U.S. Energy Information Administration, *Short-Term Energy Outlook*, January 2016

Generation onto the Electricity Grid



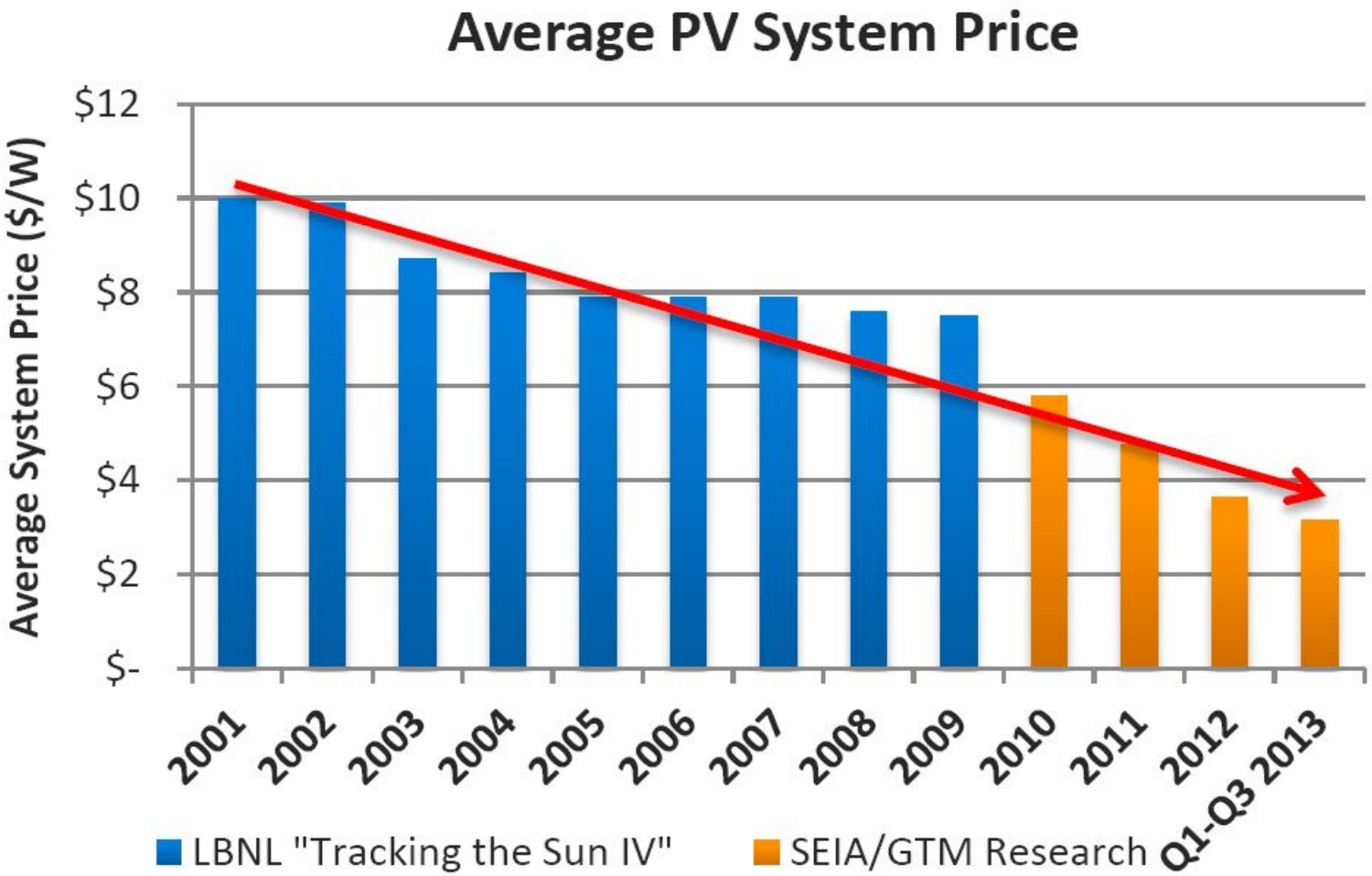
Source: U.S. Energy Information Administration, *Electric Power Monthly*

Energy Efficiency, Solar and Gas are the Lowest Cost Resources

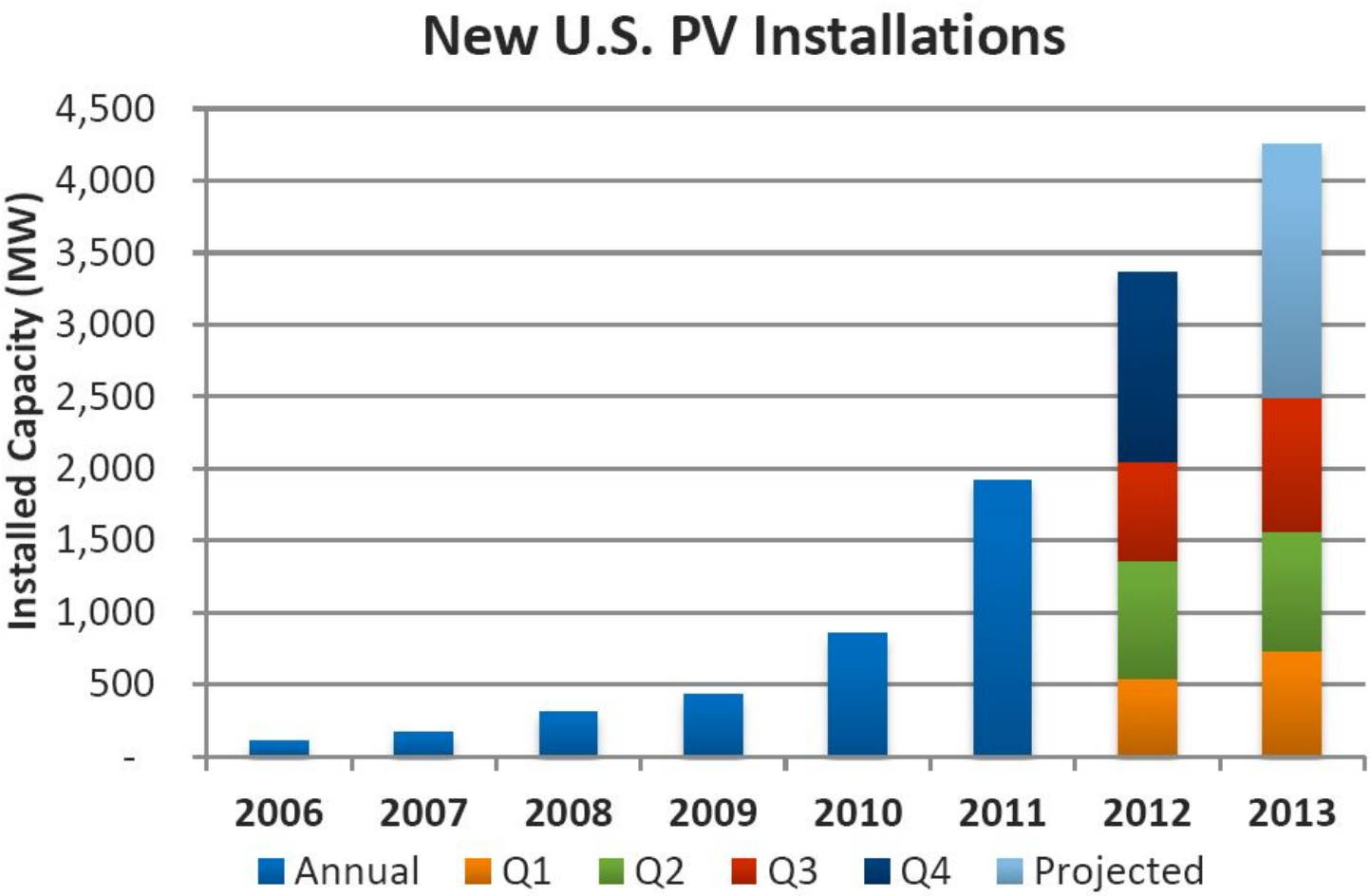


Source: Lazard, 2015

Costs Continue to Decline



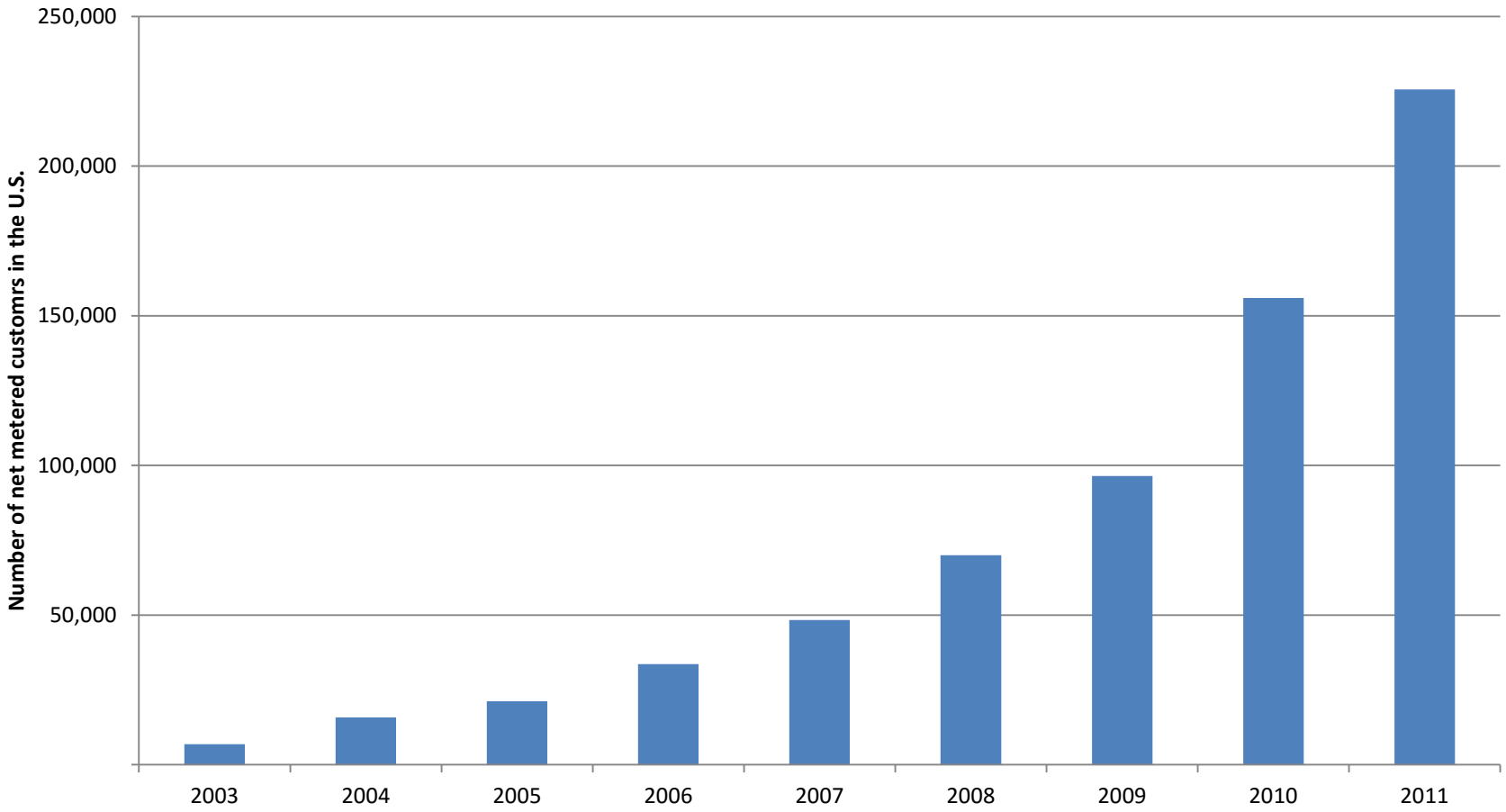
Distributed Generation is Growing



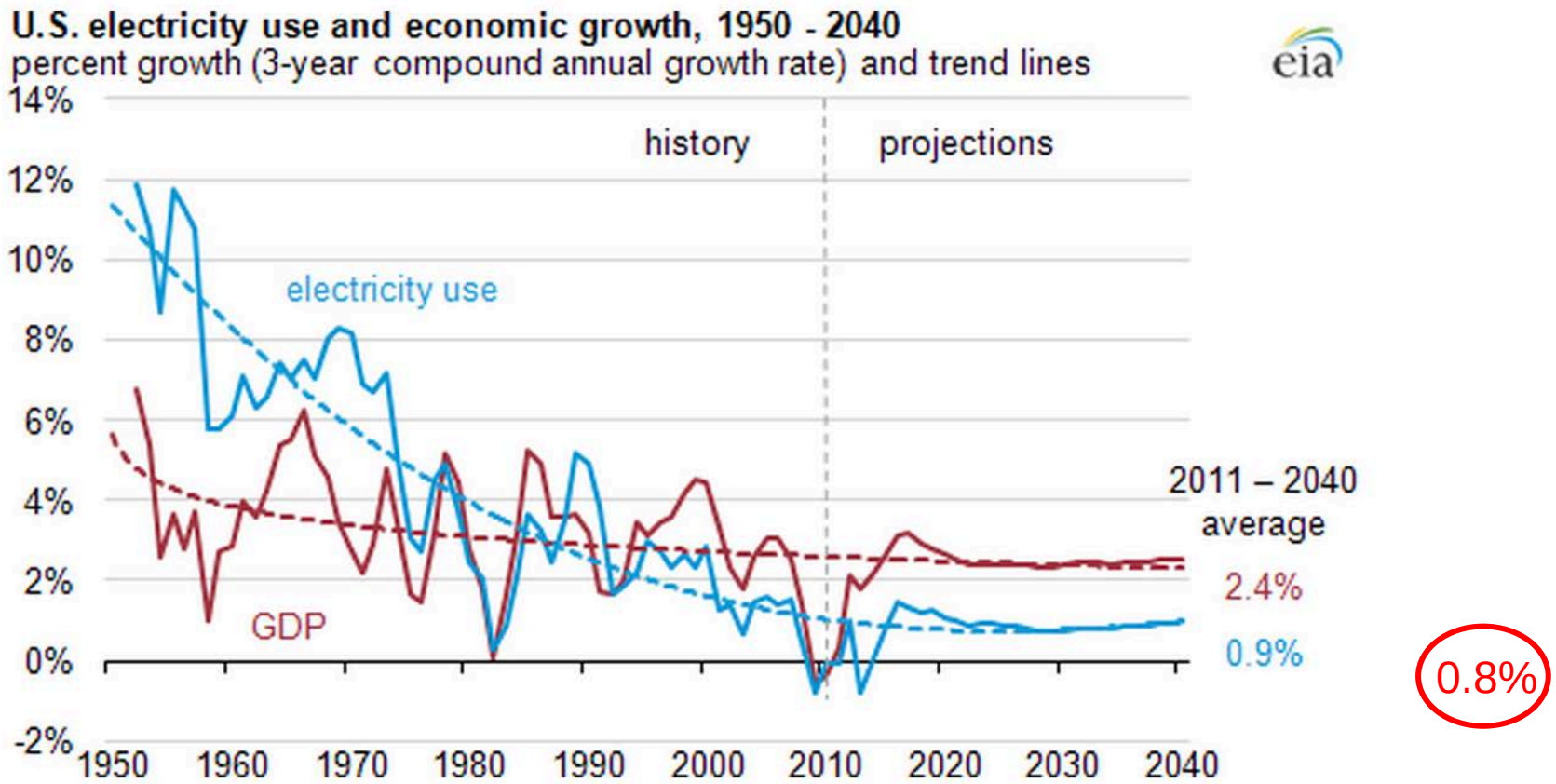
More than 30% growth/year since 2001;

Cumulative: More than 11 GW

Net Metering Growth

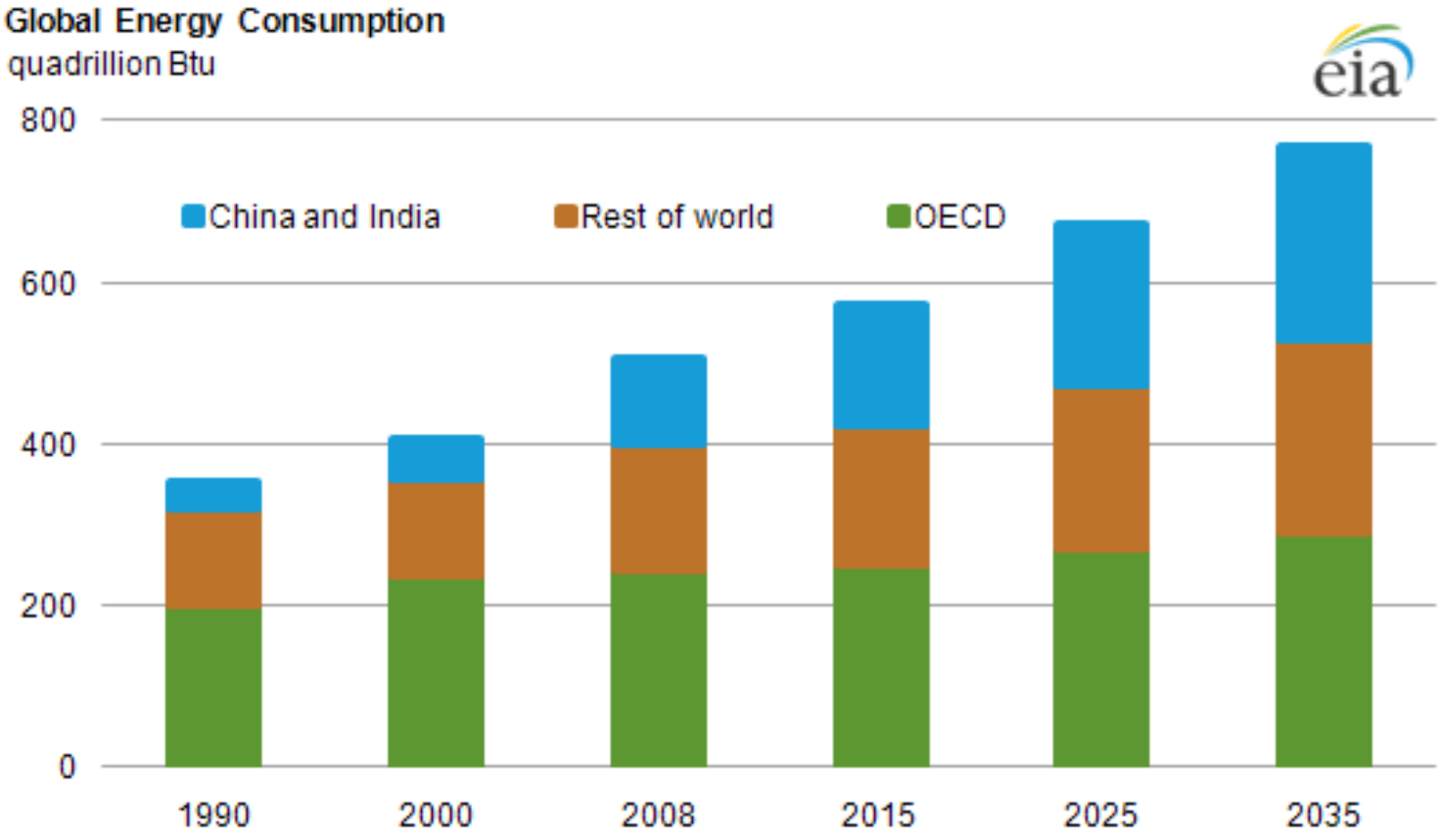


U.S. economy and electricity demand growth are linked, but relationship is changing



Source: U.S. Energy Information Administration, Annual Energy Outlook 2013 Early Release.

Global Energy Consumption is Growing



Source: EIA

Power Sector Transformation: Demand Side Management

- For 100 years, we've managed supply only
- We can now manage electricity demand, too
- Further, "supply" ≠ centralized generation
- Likely will evolve into series of "markets"
- What role for regulators, the regulatory compact, in these uncharted waters?

nest
MONDAY
12A 4A 8A 12P 4P
72
70
61

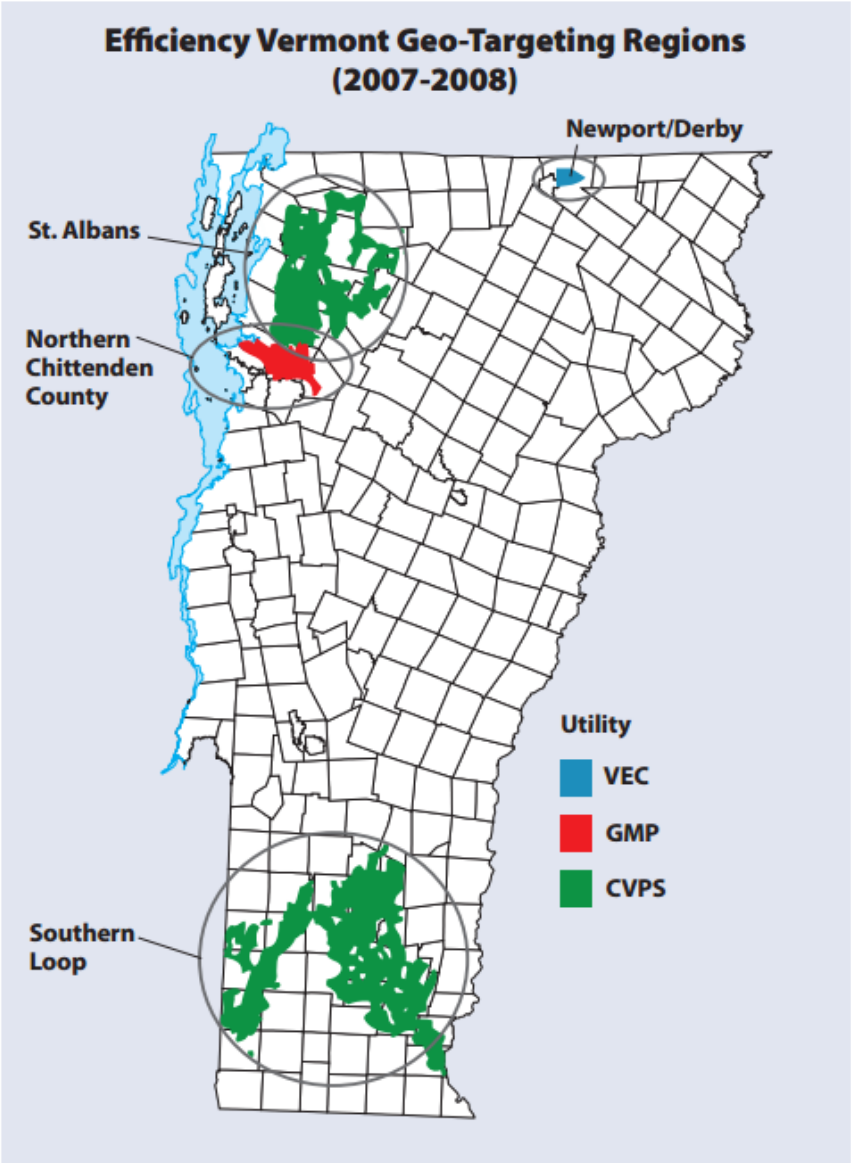
Grid **Value** from DER – Differentiate by:

- **Time**
  - Peaks and managing predictable solar, generation, and consumption patterns
- **Location**
  - High marginal cost places
- **Attribute**
  - Unbundled energy, capacity, ancillary, RE

Geo-Targeting of Energy Efficiency

- Vermont PSB annually determines specific areas to target with EE investment to avoid transmission capacity costs.

Figure 7 [47]



Non-Transmission Pilot in Maine

Boothbay peninsula for the Pilot Project – Approx. 30 MW Peak.

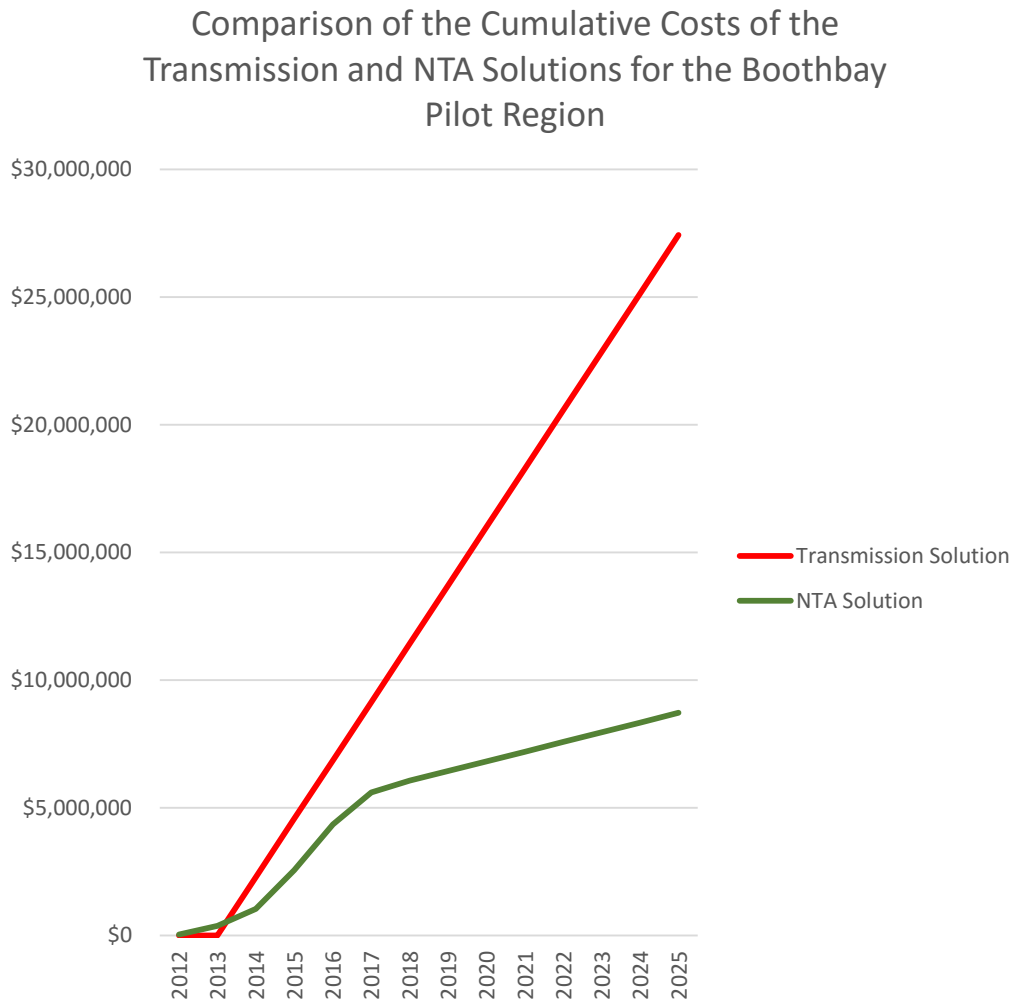
Source: The Grid Solar Project for Grid Reliability, Feb. 8, 2016

Maine NTA Pilot Lessons Learned to Enhance NTA Reliability and Resilience

- Passive resources (energy efficiency) are extremely reliable and available
- Storage resources (ice bears) performed at 98% availability in the summer of 2015
- Commissioning period is advisable for active NTA resources
- Active NTA resources like all generators are not 100% reliable
- Smart grid resources were not proposed due to lack of system to measure, report, and bill based on AMI meters (despite near 100% AMI deployment)
- With no way to use AMI data, there was essentially no economic value to customer supply-side NTAs, and home smart grid technologies cannot currently interact with the utility system, making home smart grid far less attractive to consumers

Transmission Costs Dwarf NTA Costs

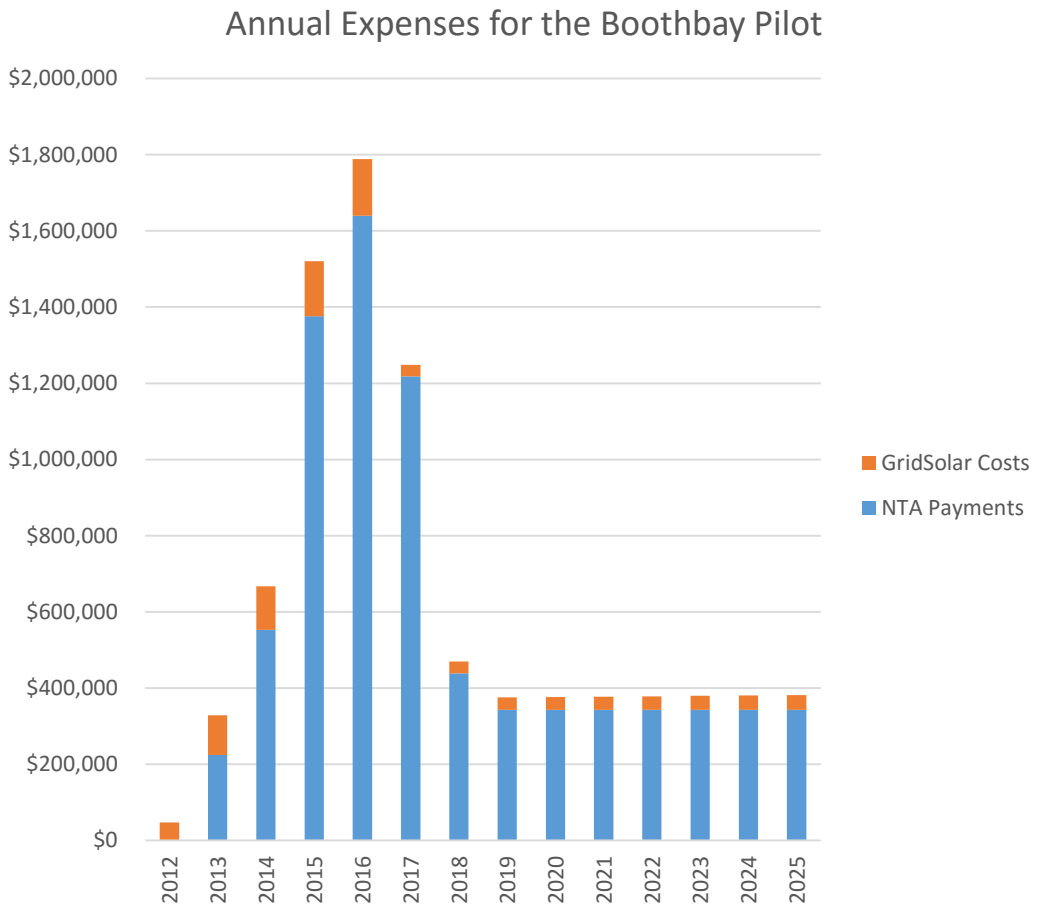
- Transmission solution had both higher capital costs and higher rate of return
- Even accounting for start-up and initial investment in NTA, its costs dwarf the transmission solution



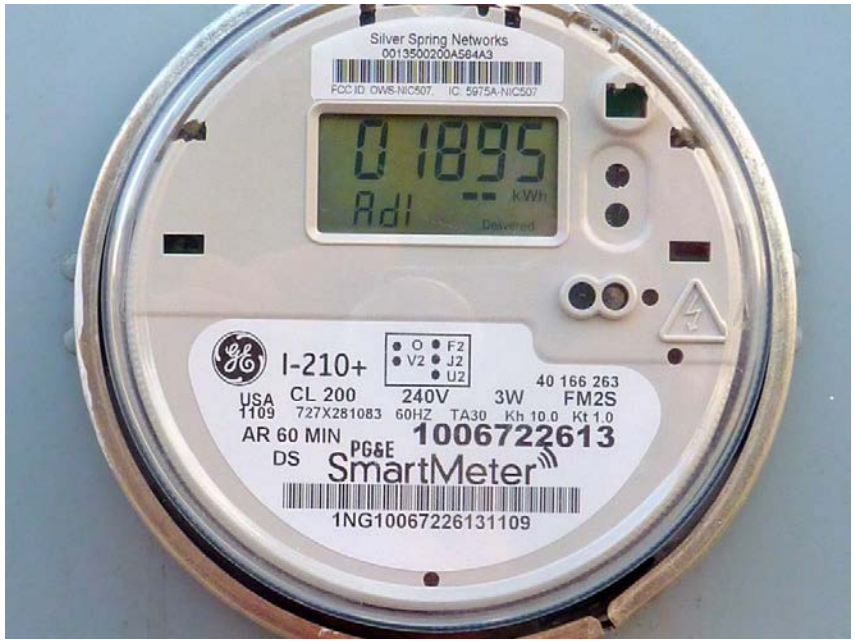
Source: The Grid Solar Project for Grid Reliability, Feb. 8, 2016

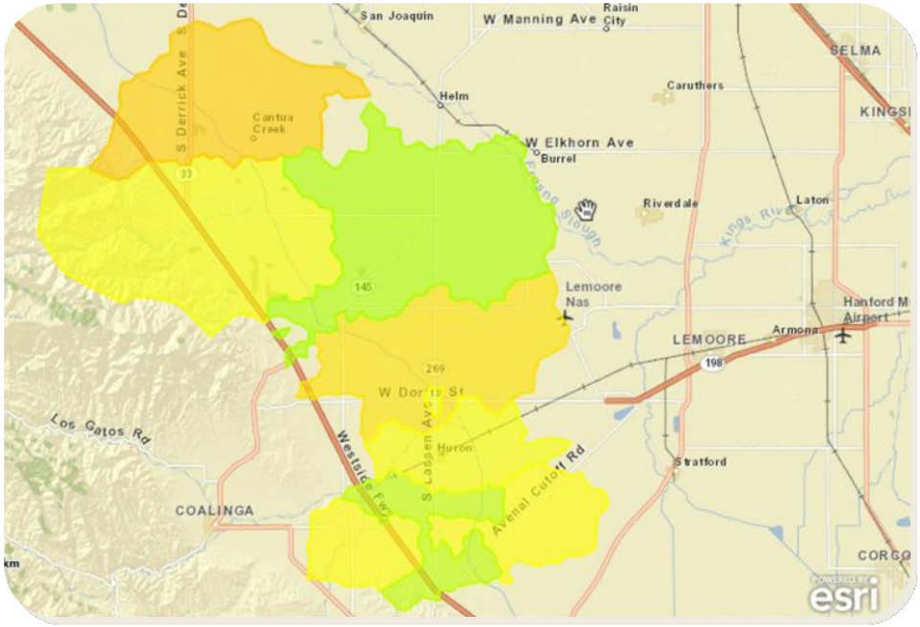
Flexibility: Scaleability and Modular DER Design Can Change with Time, Need

- Initial NTA elements can be scaled and scaled back
- NTAs can be modular: elements abandoned and added based on need, necessity, performance & costs



Advanced Technology Deployment is Underway for Grid Elements





Untapped Potential of Electric Water Heaters

- Northeast has ~5 million electric water heaters. Each is 4.4 kW when on; about 0.5 kW contribution to peak demand on a diversified basis.
- Control of these would provide about 2,500 MW of peak-load curtailment without discernible consumer impact.

Census:

Preliminary Release: August 19, 2011
Final Release: April 2013

Table HC8.8 Water Heating in U.S. Homes in Northeast Region, Divisions, and States, 2009

Million Housing Units, Final

		Northeast Census Region							
			New England Census Division			Middle Atlantic Census Division			
Water Heating	Total U.S.[1] (millions)	Total Northeast	Total New England	MA	CT, ME, NH, RI, VT	Total Middle Atlantic	NY	PA	NJ
Fuel Used by Main Water Heater									
Natural Gas	58.3	11.4	2.3	1.4	0.9	9.1	4.4	2.0	2.6
For One Housing Unit	49.6	7.9	1.6	1.1	0.6	6.3	2.5	1.7	2.1
For Two or More Housing Units	8.7	3.5	0.7	0.4	0.3	2.8	1.9	0.4	0.5
Electricity	46.8	5.1	1.4	0.5	0.9	3.6	1.2	2.0	0.4
For One Housing Unit	43.7	4.3	1.2	0.4	0.8	3.1	0.8	2.0	0.3
For Two or More Housing Units	3.0	0.8	0.2	0.1	0.1	0.6	0.5	Q	0.0
Propane/LPG	4.2	0.7	0.2	0.1	0.1	0.5	0.2	0.3	0.0
Fuel Oil	3.6	3.5	1.5	0.5	1.1	1.9	1.3	0.5	0.0
Other	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Do Not Use Hot Water	0.4	Q	N	N	N	Q	Q	Q	N
Percent Electric Water Heat	41%	25%	26%	20%	30%	24%	17%	42%	13%

Energy Related Pollution

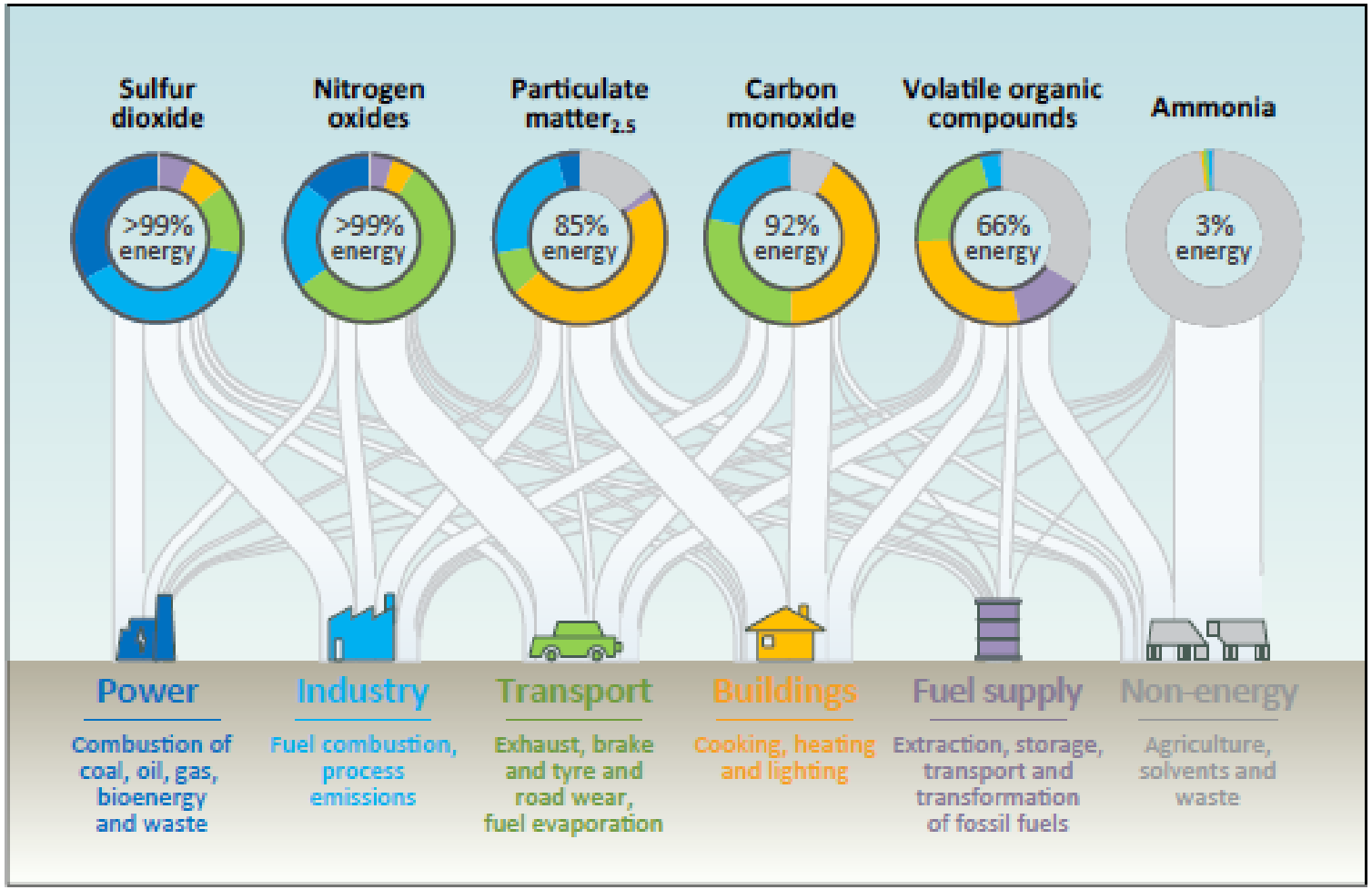
Figure 1.1 ▷ Examples of sources of energy-related air pollution

Photo credits: (a) © Bankwatch, *https://goo.gl/NYsznY*, CC BY-NC-SA 2.0; (b) and (d) © GraphicObsession; (c) © Global Alliance for Clean Cookstoves; (e) © Roberto Venturini, *https://goo.gl/FVGrfU*, CC BY 2.0.

Source: IEA, Energy and Air Pollution, World Energy Outlook, 2016, p. 22

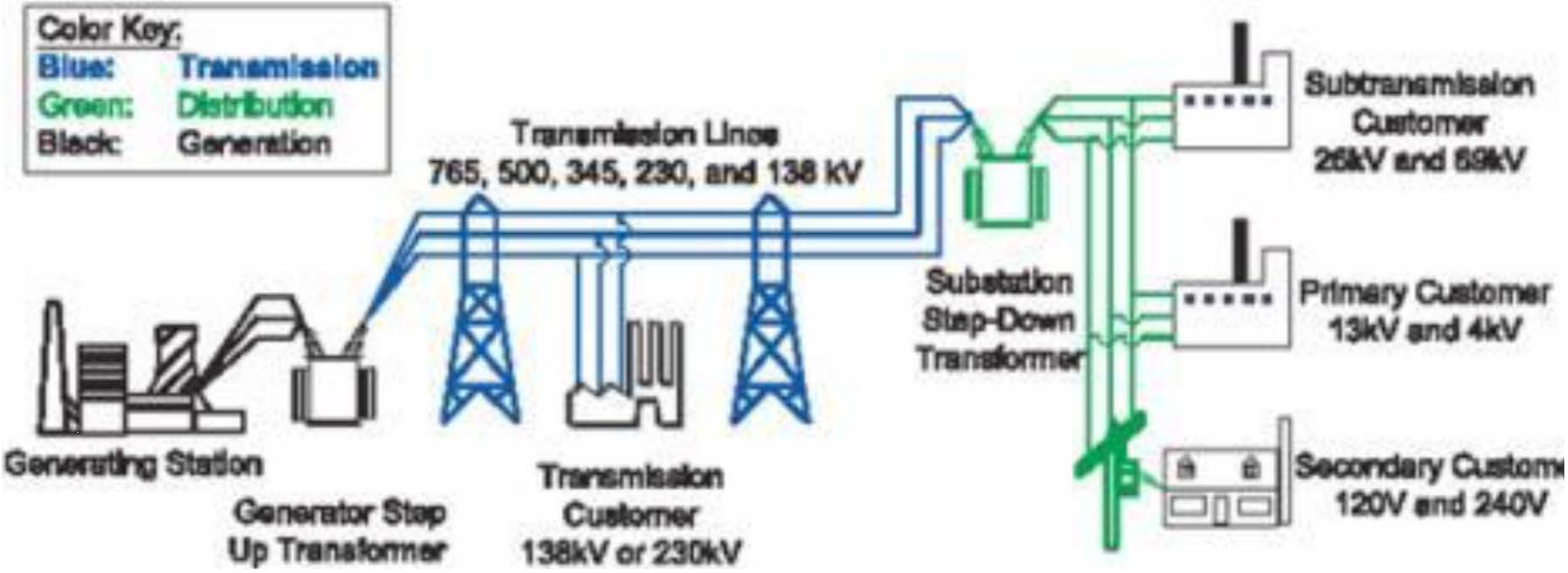
Pollution is Largely Related to Energy

Figure 1.3 ▷ **Selected primary air pollutants and their sources, 2015**



Source: IEA, Energy and Air Pollution, World Energy Outlook, 2016, p. 27

The 20th Century Electrical Power System We Grew Up With



Power Sector and Utility System Are Changing

US DOE

Consumer Decisions Shape Distribution

- Rates are **prices**
- Prices represent a **message to consumers**
- Utility Prices **signal system value**

- Consumers have **new choices**,
  - Is there **alignment** between customer value and grid value?

UBER

airbnb

Utility DIVE

TOPICS FEATURES

Will utilities become Uber for DERs?

As the industry debates the role of the utility in a distributed energy future, utility leaders are touting a network approach

By Krysti Shallenberger | March 30, 2016 print

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BlackRock warns on stranded assets

Channels: Equity, Investors, Stranded Assets, COP

Companies: BlackRock, Carbon Tracker Initiative, CTI, AP4

People: Warren Buffett

04 November 2015

BlackRock has warned that companies with high-cost fossil fuel reserves are at risk of being devalued, adding that "climate change has arrived as an investment issue".

The world's biggest asset manager believes that, as efforts to tackle global warming gather pace, "regulatory risks are becoming key drivers of returns" and there is the potential for fossil fuel assets to be devalued, or rendered 'stranded', as policies are brought in to reduce emissions.

assets of fossil fuel companies could be left "stranded" by tougher rules to curb climate change.

Rate Design Issues

- Key issues for Rate Design and related issues nationally are:
  - Time-Varying Pricing (TOU, CPP, etc.)
  - Fixed Customer Charges
  - Demand Charges
  - Inclining Block Rates (IBR)
  - Net Energy Metering (NEM)
  - Decoupling efforts

A Declining Block Rate Design

What does this rate design say?

An Inclining Block Rate Design

What does this rate design say?

$0.95 $2.05 $3.50

Smart Technology Allows Decentralized Consumer Level Solutions: How to Integrate?

Energy companies and consumers will increasingly make energy cost and risk management choices at the consumer and local levels

Enabling Technology and Services

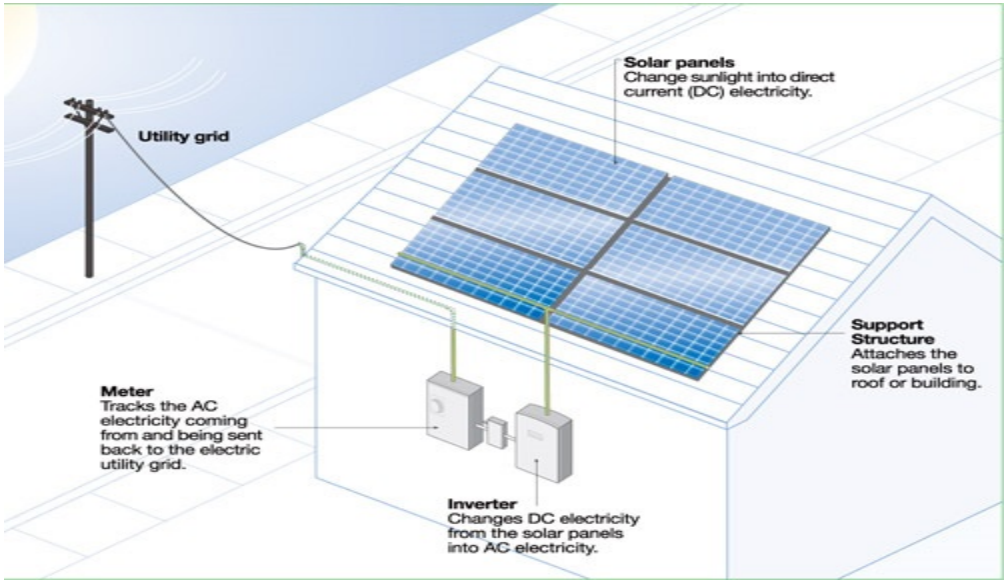
Real cost rates work best with enabling technology – "Set and Forget"

Role of energy service companies?

Aggregators?

Smart Meters/Distributed Generation

Smart meters can power flows of DG in both directions on interval basis to determine billing (and value transactions)



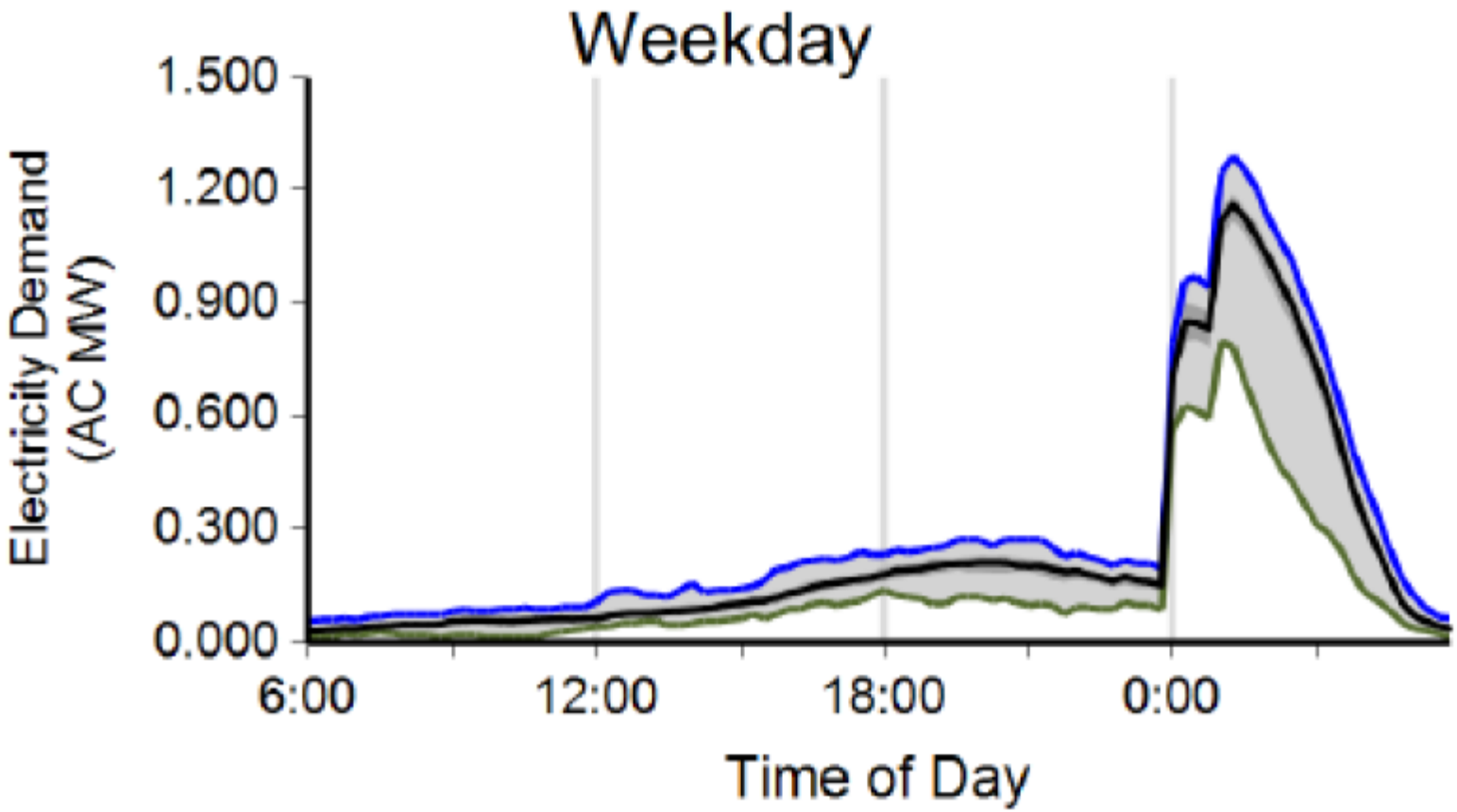
Electric Vehicles

- New Utility Market

  But to encourage efficiency, EVs should be charged off-peak

- Provide multiple ancillary services
- Potential source of on-peak power (V2G)

San Diego's Off-Peak Charging

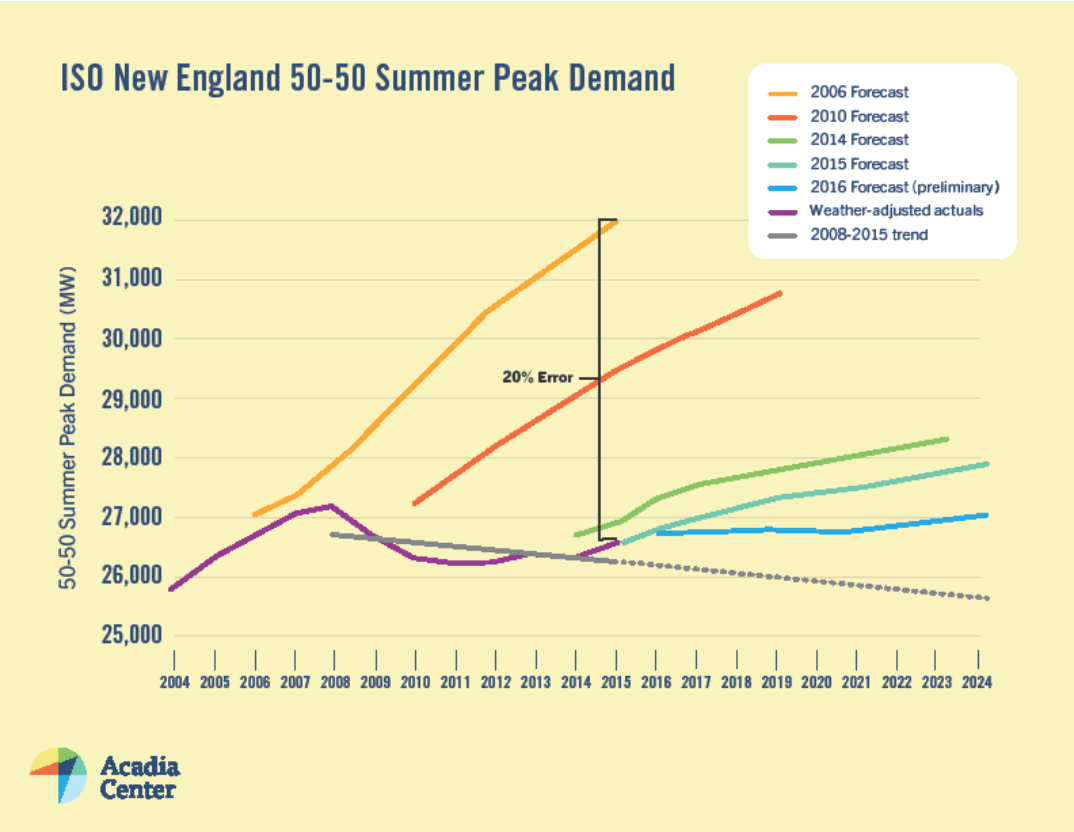


Rate Design Approaches to Complement a Smart Future

- Grid technology to make smart rates work for consumers
- Smart rates such as time-varying and dynamic rate designs to work with advanced technology
- Revenue regulation ensures utilities earn a fair return

Current System Problem: Peak Load Projections Have Been Overstated

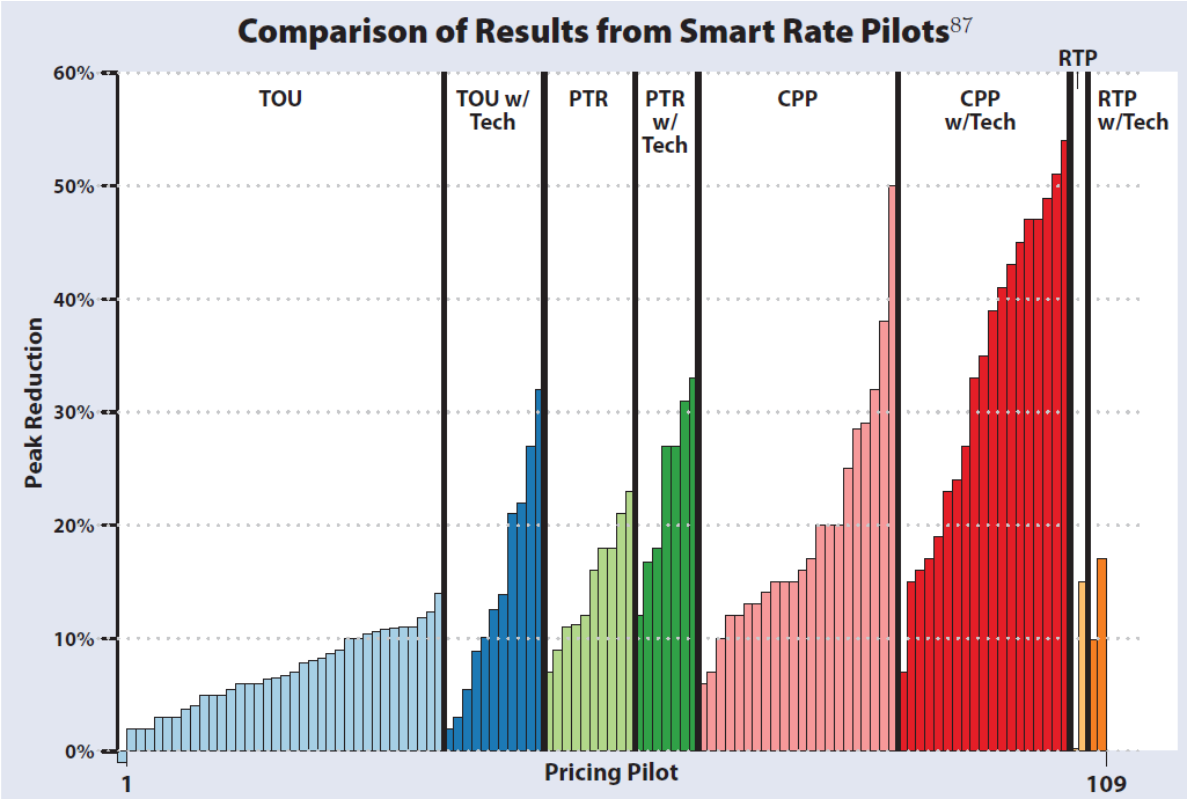
- Energy efficiency and DERs are flattening load growth
- Both transmission and distribution may be built on erroneous peak load projections



Source: Acadia Center: The Hidden Costs of Energy: Overpaying for an Outdated System (2016), http://acadiacenter.org/wp-content/uploads/2016/06/AC_transmissionmemo_spreads_finalforweb.pdf

Smart Rates Can Reduce Total System Costs & Customer Bills

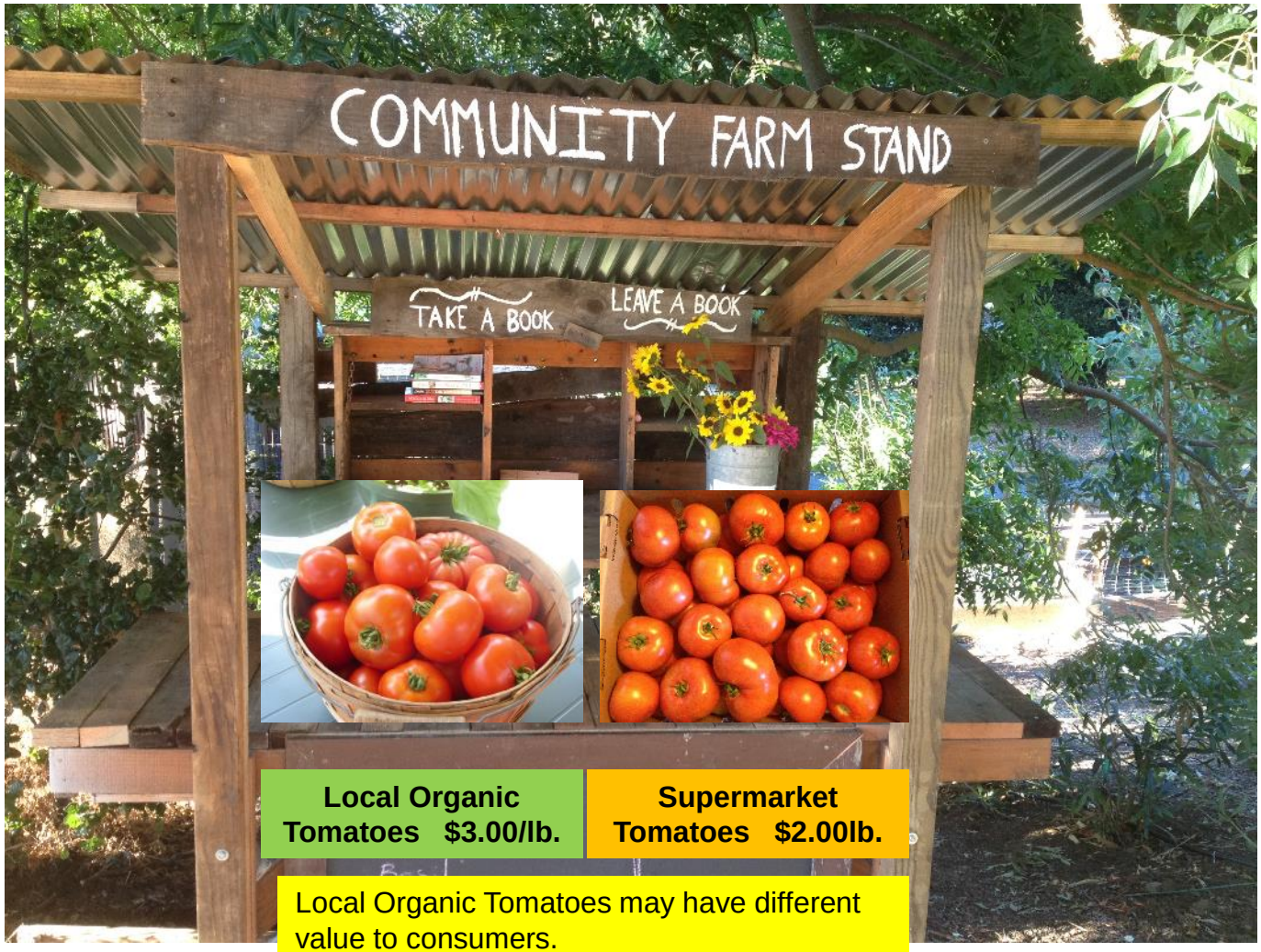
Smart rates can produce significant peak load reductions and shift energy consumption



Rate Design Effect on Usage

	Simple Flat Rate	Inclining Block	High Fixed Charge	Demand Charge
Customer Charge	$ 5.00	$ 5.00	$ 45.00	$ 5.00
Demand Charge	None	None	None	$8.00/kW
First 500 kWh	$ 0.12	$ 0.08	$ 0.08	$ 0.08
Over 500 kWh	$ 0.12	$ 0.15	$ 0.08	$ 0.08
Impact on Usage		↓	↑	↑

All Kilowatt-Hours Are Not Equal



Local Organic Tomatoes $3.00/lb.	Supermarket Tomatoes $2.00lb.

Local Organic Tomatoes may have different value to consumers.

Other Competitive Industries?

Typical Utility Price List:

Do you see this type of price list in a competitive market?

	cluding All Adjustments		
Base Rate	**Rate**	**Usage**	**Amount**
Customer Charge	$5.565	1	$5.57
First 500 kWh	$0.09291	500	$46.46
Next 500 kWh	$0.11517	500	$57.59
Over 1000 kWh	$0.13743	266	$146.17

Simple Pricing

Simple pricing enables informed consumer choice

Some Trends Are Clear

- Advanced grid technology deploying
- More valuable consumer choices
  - Consumer interest in energy services growing
  - Distributed Energy Resources – Moore's Law?
  - What happens if storage becomes more accessible to consumers?
  - Clean energy resources proliferating
- What will utilities and their regulators do?

Distribution-ISO (D-ISO)?

- Consider independent entity to procure and control NTA resources to provide for grid reliability at the distribution level
- Similar RTO function at wholesale market level in procuring Demand Response but would operate at retail/distribution level
- Ownership of NTA resources?
- Utility role in procurement and control of resources – but institutional preference to favor rate base and higher ROR assets?

What Might Utilities and Regulators Do?

- Establish regulatory structures that are flexible and accommodate a wide range of future consumer-driven outcomes
- Empower consumer driven decisions through smart rate design
- Ensure prices reflect differences in energy and T&D costs in time, location, and other aspects

Big Questions for States

- What to do?
  - Work with utilities to re-engineer their power sector for the future
    - CA, NY REV, MN e21, Ontario, British Columbia
    - Issue: state jurisdiction and ability to work regionally
  - Set policy/regulation/incentives in the right direction and get out of the way
    - EE/RE/DER leadership today => competitive advantage tomorrow (lower costs, lower emissions, fewer risks, greater scalability, less infrastructure, multiple co-benefits, etc.)
- Who will pay and how?
- Who will benefit and how?

About RAP

The Regulatory Assistance Project (RAP) is a global, non-profit team of experts that focuses on the long-term economic and environmental sustainability of the power sector. RAP has deep expertise in regulatory and market policies that:

- Promote economic efficiency
- Protect the environment
- Ensure system reliability
- Allocate system benefits fairly among all consumers

Learn more about RAP at www.raponline.org

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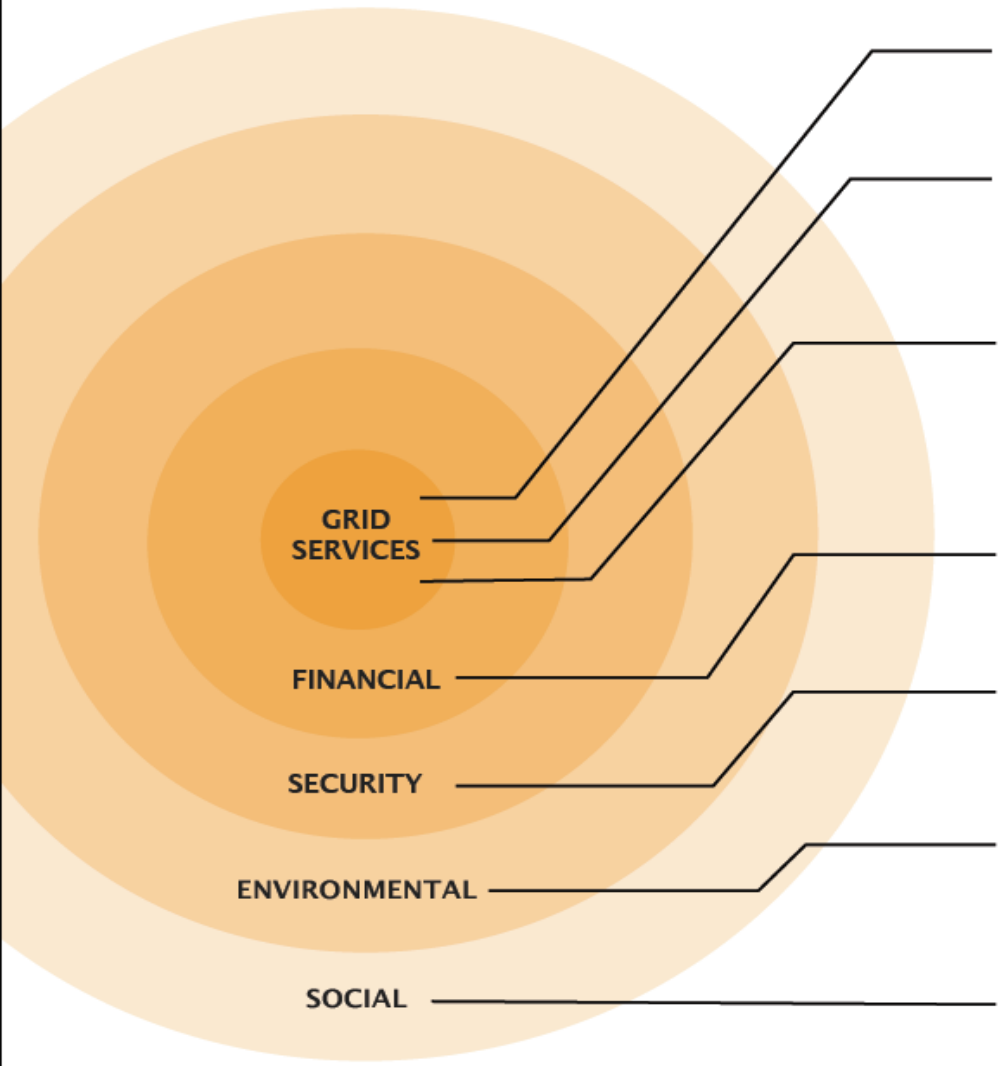
Slides in Reservation

Slides to use in response to questions

BENEFIT & COST CATEGORIES

For the purposes of this report, **value is defined as net value, i.e. benefits minus costs.** Depending upon the size of the benefit and the size of the cost, value can be positive or negative. A variety of categories of benefits or costs of DPV have been considered or acknowledged in evaluating the value of DPV. Broadly, these categories are:



ENERGY
- energy
- energy losses

CAPACITY
- generation capacity
- transmission & distribution capacity
- DPV installed capacity

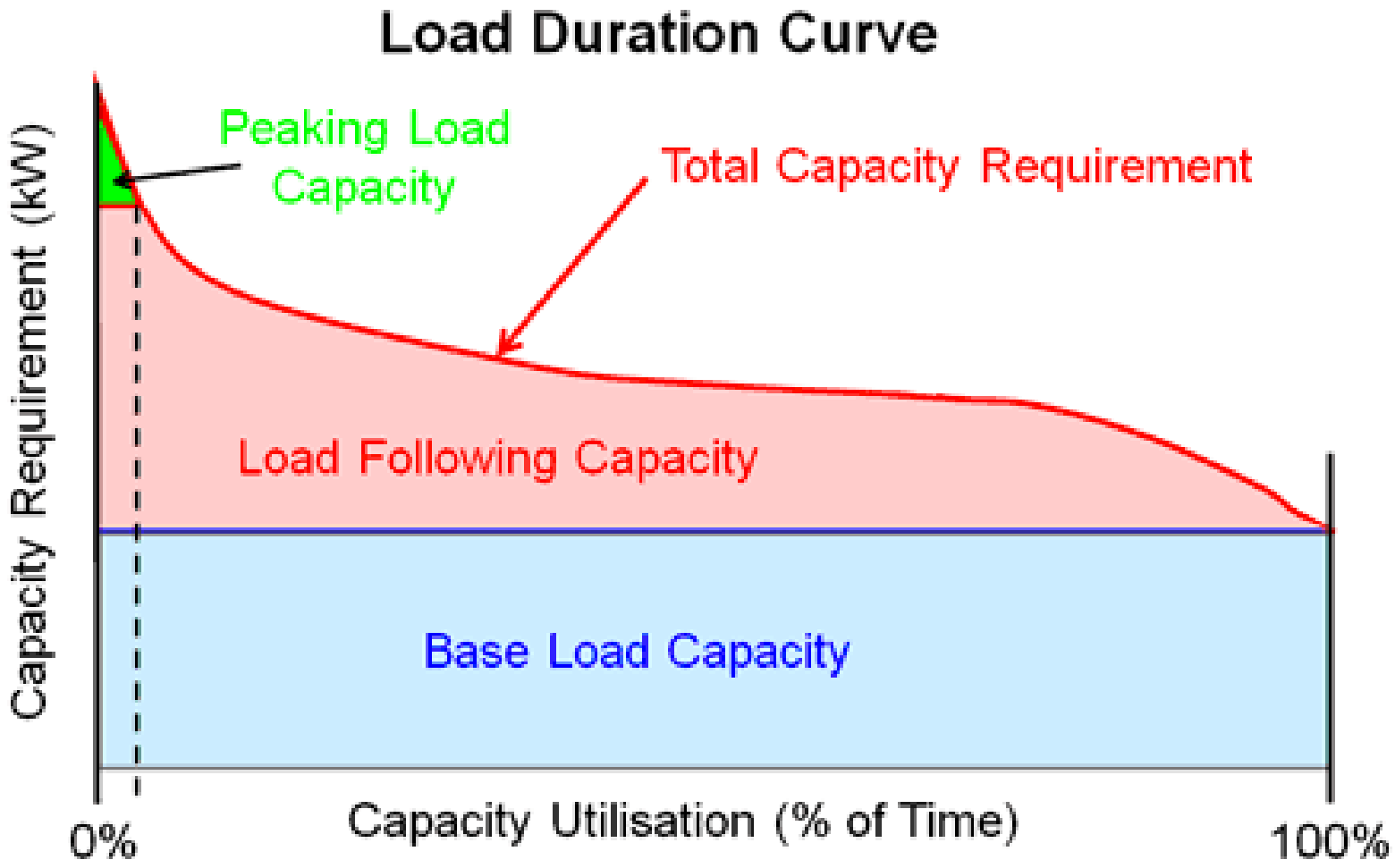
GRID SUPPORT SERVICES
- reactive supply & voltage control
- regulation & frequency response
- energy & generator imbalance
- synchronized & supplemental operating reserves
- scheduling, forecasting, and system control & dispatch

FINANCIAL RISK
- fuel price hedge
- market price response

SECURITY RISK
- reliability & resilience

ENVIRONMENTAL
- carbon emissions
- criteria air pollutants (SOx, NOx, PM10)
- water
- land

SOCIAL
- Economic development (jobs and tax revenues)


Load Duration Curve
Peaking Load Capacity
Total Capacity Requirement
Load Following Capacity
Base Load Capacity
Capacity Requirement (kW)
0%
Capacity Utilisation (% of Time)
100%

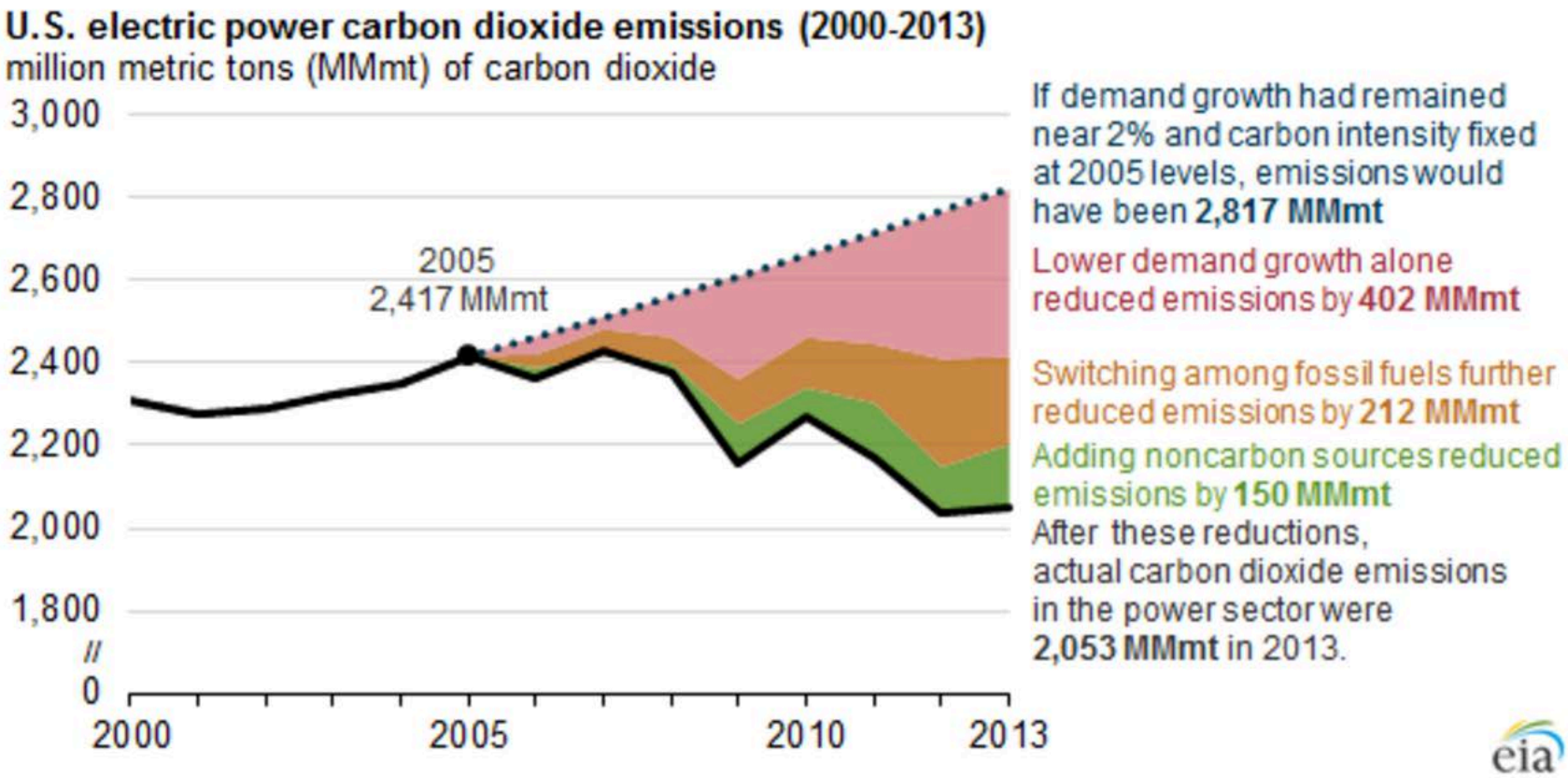
Periodic Decoupling Calculation	
From the Rate Case	
Target Revenues	$10,000,000
Test Year Unit Sales	100,000,000
Price	$0.10000
Post Rate Case Calculation	
Actual Unit Sales	99,500,000
Required Total Price	$0.1005025
Decoupling Price "Adjustment"	$0.0005025

Outcome-Based Regulation

- Used for isolated outcomes decided appropriate by state commissions
  - EE, reliability, customer service

- Could be more significant in driving utility behavior, performance, and earnings

Lower electricity-related CO2 emissions reflect lower carbon intensity and electricity use



Source: U.S. Energy Information Administration, *Annual CO_2 Analysis*